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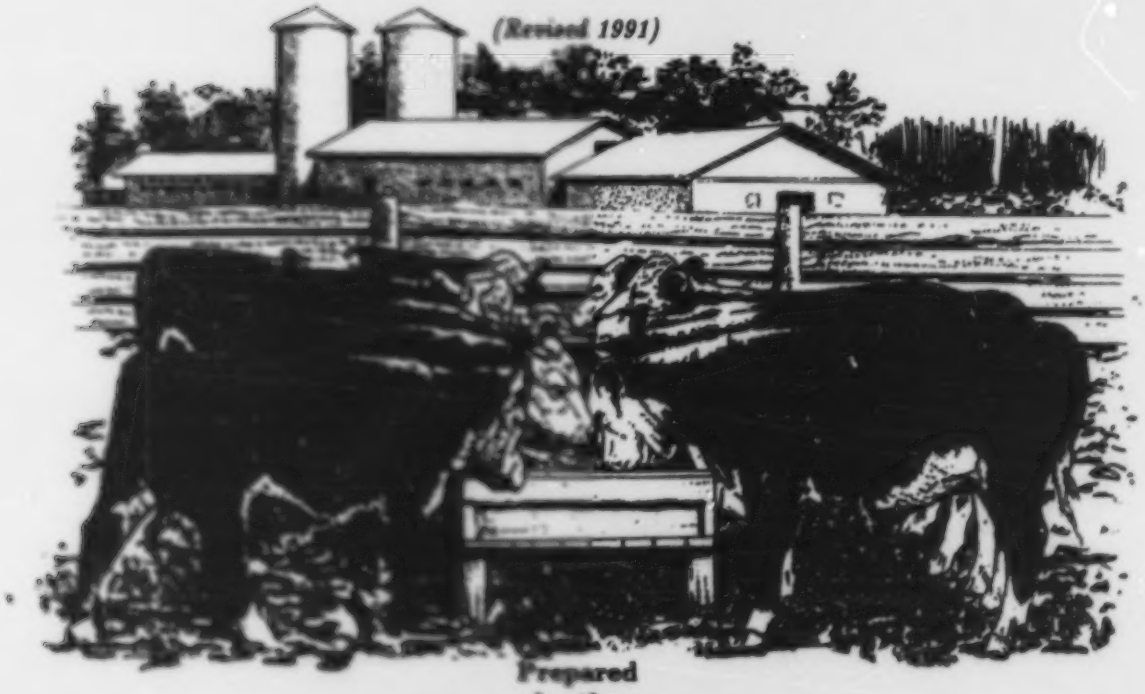
GUIDELINES FOR THE MANAGEMENT AND USE OF ANIMAL MANURE IN NOVA SCOTIA

(Revised 1991)



Prepared by the Manure Management Task Group

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Foreword

The purpose of the following guidelines and accompanying information is to create an awareness of animal manure as a valuable fertilizer source and soil amendment, while providing instruction in environmental protection. The objective is to assist farmers in planning for the proper use and management of animal manure. This is accomplished by detailing the considerations involved in manure management and by identifying acceptable manure management practices. It is intended that livestock producers who follow these guidelines will gain the best advantage from their manure resource while reducing the potential for environmental contamination. Improperly handled manure can leach or runoff, and the effluent may contaminate surface or groundwater supplies.

These guidelines apply to all farms including poultry, swine, beef and dairy, where the storage, handling and use of animal manure is a significant component of the farm operation. All new, renovated or existing farming operations are encouraged to follow the recommendations provided in the guidelines.

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2 INTRODUCTION

In Nova Scotia, more than 1.6 million tons of manure is produced annually. This by-product of farm operations can be an important source of organic matter and plant nutrients when used properly, and a potential pollutant if misused. Modern farming requires effective farm management techniques which maximize resource potential, and reduce agricultural waste. The demand for farm efficiency coupled with current fertilizer costs and increased emphasis in environmental protection has generated renewed interest in livestock manure as a resource.

3 CHARACTERISTICS OF ANIMAL MANURE

Animal manure which is composed of solid and liquid excrement, is an excellent source of organic matter and essential nutrients necessary for good soil management. The solid portion of manure contains from 20 to 50% organic matter in various stages of decomposition. Organic matter is a soil amendment which improves soil tilth, water holding capacity, nutrient availability, and biological activity. When manure is applied to the soil it increases organic matter levels in proportion to the amount of organic matter in the manure and the amount applied. Organic matter has also been attributed with increasing the relative proportion and size of soil aggregates which stabilize soils, thereby reducing soil erodibility.

It is difficult to give average figures on composition of farm manure because nutrient contents vary radically depending on livestock type, their age and condition, feed consumed and manure handling techniques. However, manure does contain significant amounts of Nitrogen(N), Phosphorus(P) and Potassium(K), and it is generally agreed that about 50% of the N, 40% of the P, and 90% of the K in manure is available within the first year after application. In addition, the residual effect from these nutrients continues to influence plant growth years after the initial application.

Manure contains significant quantities of nutrients that improve soil fertility and crop production. Table 1 shows the approximate content of major and secondary nutrients in a variety of animal manures.

Manure contains all the essential micronutrients at concentrations considered to be beneficial for soil fertility and crop production. Table 2 shows the concentration of micronutrients commonly occurring in animal manure.

Table 1: Range and Average of Nutrients in Manure(wet weight basis)

Manure Type	Dry Matter (kg/t)	N (kg/t)	P (kg/t)	K (kg/t)	Ca (kg/t)	Mg (kg/t)
Solid Dairy	138–405	2.9–6.3	0.8–1.8	1.0–6.0	1.4–7.5	0.5–1.1
Average	235	4.4	1.3	3.8	3.6	0.8
Liquid Dairy	1.0–119	0.4–6.1	0.1–1.1	0.2–5.8	0.2–12.5	0.2–3.7
Average	7.3	2.8	0.6	2.1	1.1	0.5
Solid Swine	145–234	6.7–7.8	3.8–5.1	1.5–5.3	5.6–7.4	0.8–1.4
Average	178	7.1	4.3	3.0	6.8	1.1
Liquid Swine	19–47	3.1–44.2	0.5–1.4	0.8–1.1	0.4–2.2	0.1–0.4
Average	33	3.7	1.0	1.0	1.3	0.3
Poultry	335–790	3.7–40.2	9.44–26.8	3.0–20.7	7.9–54.5	3.0–5.4
Average	562	18.4	16.1	11.5	33.9	4.3

kg/t x 2 = lbs/t

Peters, B., MacMillan, J.K. Manure Analysis Project Unpublished Data

Table 2: Average and Range of Concentration of Some Micronutrients in Manures(fresh basis)

Manure	No. of Samples		Dry Matter (%)	B (ppm)	Cu (ppm)	Mn (ppm)	Zn (ppm)	Mo* (ppm)
Liquid Dairy	11	Average	8	4	4	14	19	24
		(Range)	(5–12)	(2–6.5)	(1–17)	(8–31)	(8–78)	(14–35)
Solid Dairy	20	Average	20	6	6	70	40	–
		(Range)	(14–34)	(2–14)	(3–15)	(20–145)	(20–64)	–
Liquid Hog	20	Average	5	3	6	18	40	18
		(Range)	(1–11)	(1–5)	(2–11)	(10–62)	(15–125)	(14–25)
Solid Poultry	10	Average	57	24	20	200	280	18
		(Range)	(56–59)	(21–27)	(15–40)	(135–300)	(105–600)	(14–21)
Solid Beef	2	Average	21	4	4	31	30	–
		(Range)	(15–26)	(4–5)	(2–7)	(16–46)	(9–51)	–

* based on 4 samples/year (2–3 years)
ppm = parts per million = milligrams per litre

4 HANDLING SYSTEMS

Between the time manure is excreted and the time it is incorporated into the soil, the loss of nutrients and the resulting potential for pollution can be quite high depending on how manure is handled. A properly designed manure handling system is convenient for the operator, maintains the health and safety of humans and animals, conserves nutrients in manure, minimizes handling costs and protects the environment. Nutrients in manure are best preserved by collecting both solid and liquid excrement and preventing exposure to the ambient air and rainfall.

Manure handling methods depend largely on its moisture content. Moisture effects the consistency of manure which in turn causes manure to behave as a solid, semi-solid or liquid. Of the three types of manure, the equipment required to handle solid manure is generally least expensive. Although manure handling systems are functionally similar and some of the equipment is common, there is no single system in practice. Table 3 presents examples of the components in manure handling systems employed to manage manure of different consistencies.

When planning a new or re-modelled manure handling system, the following guidelines should be adhered to:

- **prepare a comprehensive plan detailing the objectives of the farm.** The plan should anticipate future intended actions (e.g. increasing livestock population) but must be flexible so that changes can be made as circumstances dictate. It should also include the manure handling requirements of the farm.

- **obtain a manure handling system design from the Nova Scotia Department of Agriculture and Marketing Extension Services agricultural engineers.** The system plan will incorporate farm resource considerations including economics, man power, equipment, existing structures, animal populations, site characteristics and storage capacity.

- **ensure that manure hauling and spreading equipment is suited to the type and consistency of manure produced on the farm.**

- **ensure that storage structures have the capacity to hold the total volume of manure, wastewater and bedding produced between periods of land application. IT IS RECOMMENDED THAT FACILITIES HAVE CAPACITY FOR A MINIMUM OF 7 MONTHS STORAGE.** The size of storage depends on the type and number of animals, the length of time the manure is stored and with liquid manure, the volume of dilution water added. A manure handling plan designed by NSDAM engineers will determine the size of manure storage required for your farm.

- **time the unloading and field application of manure to reduce the potential for environmental contamination, and to provide the greatest benefit for soils and crops.** Avoid spreading manure on snow, frozen ground, sensitive crops or in excess of crop requirements.

- **make storage facilities manure tight to contain and protect manure from the weather thereby providing the greatest conservation of plant nutrients and the best protection against pollution.**

- **keep manure handling to a minimum, agitating manure, particularly in liquid form, causes the gaseous loss of nitrogen which produces odors.**

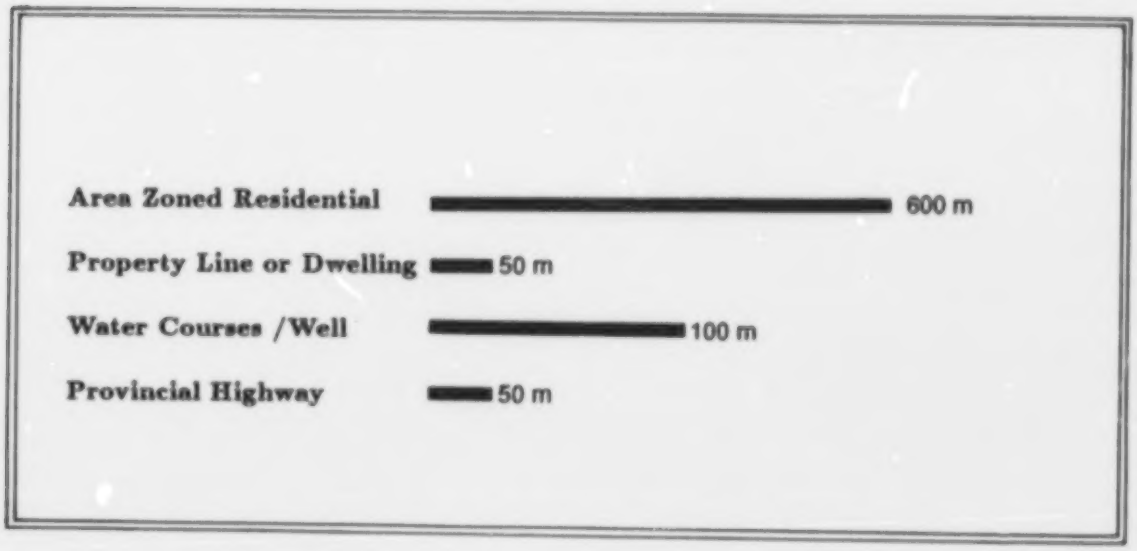
- **avoid excessive additions of hay and bedding to manure which can alter the carbon/nitrogen (C/N) ratio of manure and reduce the content of available nitrogen for crops.**

- **plan the location of the animal production/manure storage unit so that it is adequately removed from water sources and non-compatible uses.** Figure 1 lists the recommended separation distances for livestock production and storage units.

Table 3: Components of Typical Manure Handling Systems

Manure Form	Collection	Transfer	Storage	Treatment	Disposal Utilization
Solid (<84% water)	Shovel Front-end loader Gutter cleaner Litter	Conveyor Front-end loader Piston pump	Floor Bunk silo Deep pit	Stack Compost Dry Incinerate Produce methane	Fertilizer Field Spread Litter Plant bedding feed supplement
Semisolid (84–88% water)	Shovel Front-end loader Gutter cleaner Alley scraper Slotted floor	Conveyor Auger Piston pump Flushing	Beneath floor Deep pit	Compost Lagoon Produce methane	Field spread Inject into soil
Semiliquid (slurry) (88–95% water)	Front-end loader Gutter cleaner Alley scraper Slotted floors	Auger Piston pump flushing Pump Gravity flow	Beneath floor Deep pit Tank	Lagoon Produce methane	Field spread Irrigate Inject into soil
Liquid (>95% water)	Gutter cleaner Slotted floors	Flushing Pump Gravity flow Separation	Beneath floor Deep pit Tank	Lagoon	Field spread Irrigate Inject into soil

Figure 1: Minimum Recommended Separation Distances for Animal Production and Manure Storage Units(metre)



5 MANURE USE IN CROP PRODUCTION

Economically and environmentally the best method of utilizing manure is to spread it on the land, therefore it is the only use recommended in these guides. The value of manure exerts an influence greater than the nutrient content it provides to crops. If applied properly and in the correct amounts, manure not only provides nutrients but also acts as a soil amendment. Furthermore, field application of manure is an efficient, economic and environmentally safe method of farm manure management.

When using manure as a nutrient source and as a soil amendment be sure to:

- **take regular soil tests to determine the nutrient status of fields and fertilizer requirements of the crop to be grown.** Fields should be tested for nutrient status every 2 or 3 years.

- **have manure tested to determine its fertilizer value and then reduce chemical fertilizer applications accordingly.** Remember, only about 50% of the N, and 40% of the P is available in the first year, but manure also has a residual value most commercial fertilizers lack. Table 4 shows the reduction in chemical fertilizer applications that can be expected where manure is applied in the same crop year. The same general principles observed in the application of any fertilizer should be followed when applying manure to the land.

- **base manure application rates on soil characteristics and nutrient requirements.** Sandy or gravelly soils tend to have lower nutrient holding capacity and are more prone to leaching. Where possible apply lower rates of manure more frequently to sandy soils to avoid potential problems. Loamy or clayey soils have higher nutrient retention capacity and are less permeable. Therefore higher rates of manure can be applied to these soils. Table 5 shows the livestock populations of various animal species which produce one "animal manure unit" of manure annually. An animal manure unit is defined as the number of that kind of livestock that would produce 70 - 80 kg of nitrogen in their manure annually. Figure 2 shows the minimum hectareage required for two soil types in order to safely utilize annual manure production.

- **have adequate land area available to efficiently utilize the manure produced.** It is generally economically feasible to transport manure to most fields on your farm and still gain value from the manure as a soil amendment and fertilizer. Therefore, an inventory should be made of the land base within distance of the storage facility that is suitable for manure application. The carrying capacity of the land base should then be calculated in order to determine how many animal manure units can be applied. If the animal population exceeds the capacity of the land base additional land should be rented, bought or make arrangements with other landowners in order to utilize the manure efficiently and safely. Comprehensive lease agreements must be negotiated and signed for rented land to insure that land is available when required for the spreading of manure.

- **apply manure following minimum recommended separation distances for water resources and non-compatible land uses.** Table 6 provides minimum separation distances for manure application on farmland.

- **calibrate manure spreading equipment in order to ensure correct application rates.** Table 7 can be used to determine load capacities of typical manure spreaders.

- **attain the most effective use of manure nutrients through spring application and immediate incorporation.** However, timing and technique of manure application can be adjusted somewhat to the requirements of the crop being fertilized. Figure 3 shows the recommended seasons of manure application for commonly grown crops.

- **apply manure only to crops that require nitrogen and on soils requiring phosphorus and potassium.** Corn and grass hay or pastures have higher nitrogen requirements than many other crops and therefore respond more to nitrogen in manure. Legumes such as alfalfa and trefoil, do not make efficient use of the nitrogen in manure. If manure must be applied to legumes, select the thinnest and oldest stands, preferably after first cut.

- **avoid application of liquid manure on crop foliage as far as possible because it can damage crops.**

- **avoid spreading manure on wet land.** This will reduce the potential for soil compaction caused by heavy spreader equipment traffic on sensitive soils.

- **incorporate manure into the soil as soon as possible after spreading, except for top dressing.** This technique decreases nutrient losses and reduces the potential for runoff and pollution. Figure 4 shows the gaseous loss of Nitrogen in manure after surface application and prior to incorporation. When applying manure as a top dressing, maximum nutrient benefit can be obtained by spreading manure on cool, cloudy, windless days prior to a gentle rainfall.

- **coordinate manure applications with a fertilizer and lime program for maximum benefit.**

Table 4: Reductions in Fertilizer Application Where Manure is Applied in the Same Crop Year[1]

Class of Livestock	Nitrogen(kg/ha) F.&W.[2]	Spr.[2]	Spr.C[2]	Phosphate P_2O_2	Potash K_2O(kg/ha)
Liquid Manure at 10 cubic metre/hectare (900 gal./acre)					
Cattle, Mixed Livestock	5	10	12	4	16
Swine	8	15	19	7	14
Poultry	23	46	58	22	26
Solid Manure at 10 tonnes/hectare(4.5 tons/acre)					
Cattle, Mixed Livestock	12	24	30	10	44
Swine	15	30	38	20	26
Poultry	70	140	175	75	96

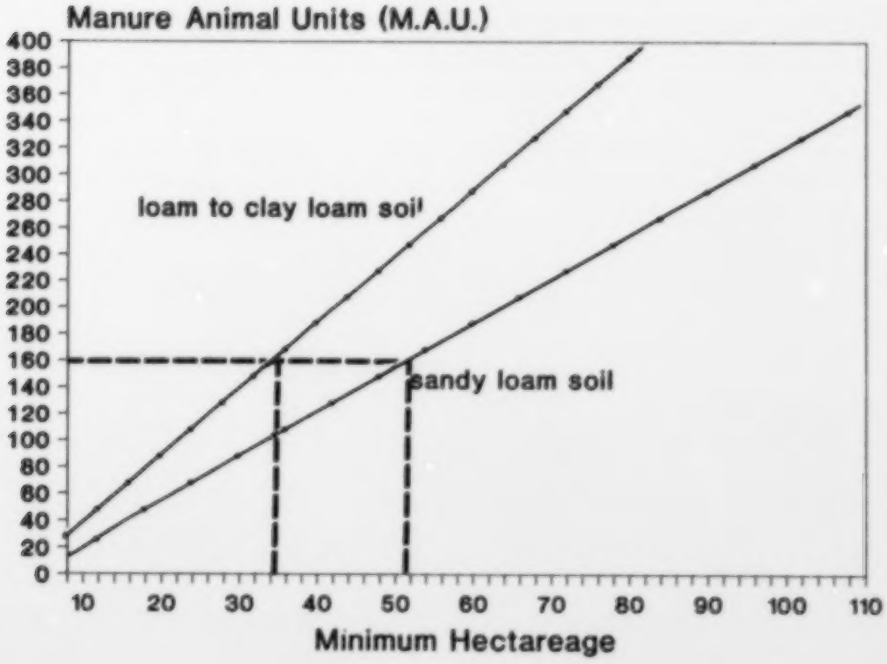
[1] These adjustments are based on slightly below average quality manure.

[2] **F.&W.** denotes fall and winter applied manure; **Spr.** denotes spring applied and not covered immediately, including surface application after seeding; **Spr.C** denotes spring applied manure injected or otherwise covered within one day of application.

Table 5: Manure Animal Units (M.A.U.) Produced (in terms of Nitrogen) as Basis for Hectareage Requirements (to be used with Figure 2)

Livestock or Poultry Type	Animal Numbers Equalling 1 M.A.U.
Dairy cow	1
Beef cow (plus calf)	1
Sheep	10
Sows	10
Laying hens	125
Beef feeders (gain 180–500 kg)	2
Hogs (gain 20–90 kg)	10
Broiler chickens or roasters (1 kg)	1000
Pullets	1000
Turkeys broilers (5 kg)	300
Heavy turkey hens (9 kg)	150
Heavy turkey toms (15 kg)	100
Veal calves (gain 40–135 kg)	10

Figure 2: Minimum Annual Hectareage Required for Manure Application



For example, a herd representing 160 manure animal units would require a minimum of 34 hectares of loam soil or 52 hectares of sandy loam soil.

Table 6: Minimum Recommended Separation Distances for Manure Application(metre)

Non–Compatible Land Use	Separation Distance (metre) clay loam & loam soils	sand & gravel soils
Dug or Drilled Wells	30	60
Water Courses		
Slope Towards Water Course		
< 2 %	20	50
2 - 5 %	50	75
5 - 10 %	100	100
> 10 %	NR*	NR

* NR = Not Recommended

Table 7: Calibration of Manure Spreaders

Tonnage Conversion of semisolid to solid manure spreaders

Size of Spreader	Heaped Solid Manure	Level Semi-solid Manure
150 bushel	2.3 tonne	1.8 tonne
200 bushel	2.9 tonne	2.5 tonne
225 bushel	3.3 tonne	2.7 tonne
350 bushel	5.0 tonne	4.5 tonne

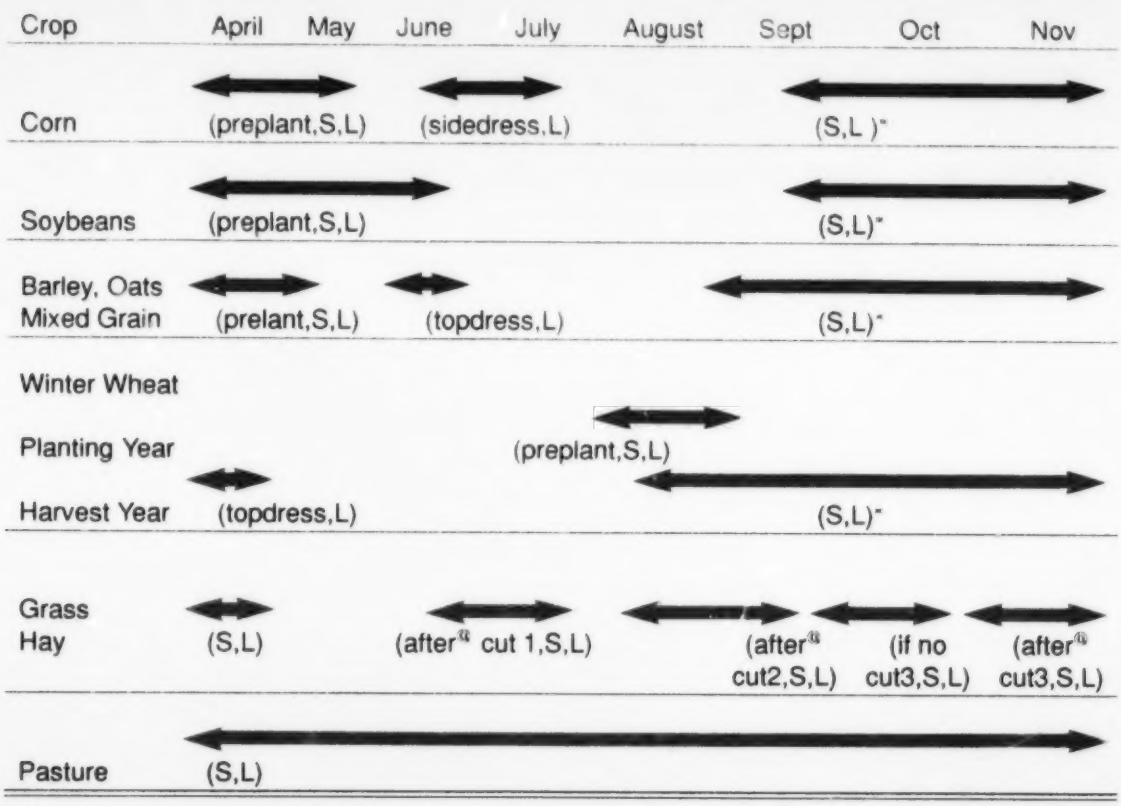
Cubic Meter Conversion of Liquid Manure Spreaders

Size of Spreader Tank	Conversion
1000 gallon	4.5 m^3
2000 gallon	9.0 m^3
3000 gallon	13.5 m^3

1 m^3 = 222 gallons

When the calculation of manure rate is achieved, one has only to refer to the back of the soil test report (a service of the N.S. Dept. of Agriculture and Marketing) in order to determine how much to reduce the total chemical fertilizer amount for each field.

Figure 3: Optimum Application Times for Common Crop Types



* fall application of manure on annuals is intended for next rotation.
@ manure should be applied within 2 weeks after cut.
S = Solid
L = Liquid
Cut1 = First cut
Cut2 = Second cut
Cut3 = Third cut

6 PASTURING LIVESTOCK

Pasturing livestock is an important, yet frequently overlooked, consideration of a comprehensive manure management system. Manure produced by properly managed grazing animals provides some nutrient benefit to the pasture. However, improperly managed grazing livestock can result in contamination of water supplies and environmental hazards.

When pasturing livestock be sure to:

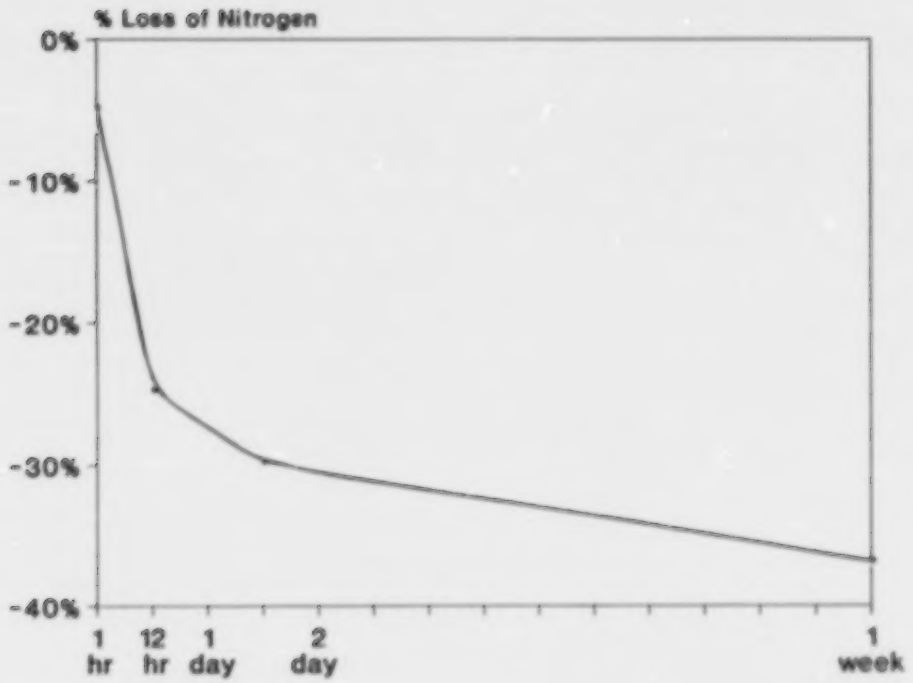
- **fence pasturing livestock from direct access to watercourses.** Livestock allowed to enter watercourses can defecate in the water as they drink and cause pollution.
- **ensure that grazing animal populations do not exceed the carrying capacity of the pasture.** Exceeding the grazing capacity of a pasture through excessive animal numbers or over grazing can reduce surface vegetative cover. As a result, manure defecated by grazing animals is less likely to be held and used by plants, and may seep or runoff into watercourses.
- **rotate animals among pastures frequently to allow plant regeneration and the breakdown and absorption of manure.**

7 ENVIRONMENTAL CONSIDERATIONS

The most serious environmental concern with manure handling and use, especially with liquid manure, is the potential for water contamination. This contamination can render water unpotable, kill or contaminate aquatic plants and animals and cause esthetic deterioration of water sources. In order to ensure the safe handling and use of manure remember to:

- **ensure that manure storages are properly sealed and are not susceptible to leaking, runoff or overflowing.**
- **prevent the discharge of manure into watercourses.**
- **never apply manure in excess of recommended rates.**
- **follow all separation distances for storage facility location and for field applications.**
- **avoid the application of manure in the winter on frozen or snow covered land.** Manure applied in winter provides little nutrient value and is a potential source of runoff and pollution.
- **avoid applying manure when soils are excessively wet.**
- **apply manure on cool, cloudy, windless days to reduce the potential for gaseous loss of nutrients and odor emissions.**
- **only apply manure on gently sloping land (less than 10% slope) to prevent runoff losses and potential water pollution.**
- **keep pasturing livestock away from direct access to water courses.**

Figure 4: Gaseous Loss of Nitrogen Following Spreading



Adapted from Maine Dairy Newsletter, April, 1981.

8 APPENDIX

Table 8: Conversion Factors for Different Manures

Dairy Manure at 12.7% D.M.				
	Tons	Imp.Gal.	Tonnes	Litre
$Yd.^3$	0.841	168	–	–
m^3	–	–	1	1000
Swine Manure (Farrow to Finish) at 9% D.M.				
	Tons	Imp. Gal.	Tonnes	Litres
$Yd.^3$	0.844	168	–	–
m^3	–	–	1	1000
Poultry Manure (Broilers) at 23% D.M.				
	Tones	Imp. Gal.	Tonnes	Litres
$Yd.^3$	0.033	168	–	–
m^3	–	–	0.029	1000

Table 9: Metric Conversion Factors

Imperial Units	Approximate Conversion Factor	Results in
LINEAR		
inch	x 25	millimetre(mm)
foot	x 30	centimetre(cm)
yard	x 0.9	metre(m)
mile	x 1.6	kilometre(km)
AREA		
square inch	x 65	square centimetre(cm^2)
square foot	x 0.09	square metre(m^2)
acre	x 0.40	hectare(ha)
VOLUME		
cubic inch	x 16	cubic centimetre(cm^3)
cubic foot	x 28	cubic decimetre(dm^3)
cubic yard	x 0.8	cubic metre(m^3)
fluid ounce	x 28	millimetre(ml)
pint	x 0.57	litre(l)
quart	x 1.1	litre(l)
gallon	x 4.5	litre(l)
bushel	x 0.36	hectolitre(hl)
WEIGHT		
ounce	x 28	gram(g)
pound	x 0.45	kilogram(kg)
short ton (2000 lb)	x 0.9	tonne(t)
AGRICULTURE		
bushels/acre	x 0.90	hectolitres/hectare(hl/ha)
gallons/acre	x 11.23	litres/hectare(l/ha)
quarts/acre	x 2.8	litres/hectare(l/ha)
pints/acre	x 1.4	litres/hectare(l/ha)
fluid ounces/acre	x 70	millilitres/hectare(ml/l)
tons/acre	x 2.24	tonnes/hectare(t/ha)
pounds/acre	x 1.12	kilograms/hectare(kg/ha)
ounces/acre	x 70	grams/hectare(g/ha)
plants/acre	x 2.47	plants/hectare(plant/ha)